Amendments to the Specification:

Please replace paragraph **[0014]** with the following rewritten paragraph:

[0014] The image taking device can take, at once, an image of a plurality of leads extending from one portion of the electronic component that is located on the side of the image taking device. Since the optical axis of the image taking device is inclined relative to the plane containing the bottom surface of the component, the image taking device can take, even if one or more leads may be more or less bent upwardly, an image of respective end portions of the leads that does not overlap the image of the main body or an image of respective base portions of the leads. In addition, even if the component may have leads extending from another portion thereof that is opposite to the above-indicated one portion, the image taking device can avoid taking an image of those irrelevant leads, i.e., can ~~taken~~ take the image of the relevant leads only.

Please replace paragraph **[0017]** with the following rewritten paragraph:

[0017] In the case where the electronic-component has a large angular-positional error that adversely influences the detection of coplanarity, it is preferred that the preliminary inspection be carried out to detect the angular-positional error and, after the error is corrected, the coplanarity be detected. If the electronic-component has a large angular-positional error, then an image of the lead is formed at a different position on the image taking face of the image taking device, or a lead that is not bent is judged as being bent. Since the image of the lead is formed as if it is inclined, the length of the lead cannot be accurately determined. Thus, the detection of coplanarity is ~~advisedly~~ adversely influenced. To avoid this, the preliminary inspection is carried out to detect the angular-positional error of the lead and correct the error before the detection of coplanarity. Though the time needed to detect the coplanarity cannot be shortened, the detection of coplanarity can be carried out at low cost.

Please replace paragraph **[0026]** with the following rewritten paragraph:

[0026] (6) According to a ~~fourth~~ sixth mode of the present invention, there is provided an apparatus for detecting a condition of an electronic component, comprising a coplanarity detecting apparatus according to any one of the first to fifth modes (1) to (5); and a second image taking device which is different from a first image taking device as the image taking device of the coplanarity detecting apparatus and which takes an image of at least the bottom surface of the main body of the electronic component as viewed in a direction perpendicular to the bottom surface of the main body, and the image processing device comprises, in addition to a first image processing portion which determines the coplanarity, a second image processing portion which processes the image of the electronic component taken by the second image taking device and thereby determines at least one positional error of the electronic component relative to the holding device in at least one direction parallel to the upper surface of the main body.

Please replace the paragraph **[0048]** with the following rewritten paragraph:

[0048] The above and other objects, features, advantages and technical and industrial significance of the present invention will be better understood by reading the following detailed description of presently preferred embodiments of the invention, when considered in connection with the accompanying drawings, in which:

Fig. 1 is a plan view showing an electronic-component mounting system constructed according to one embodiment of this invention;

Fig. 2 is a side elevational view of the electronic-component mounting system of Fig. 1;

Fig. 3 is a front elevational view showing a component mounting device in the electronic-component mounting system;

Fig. 4 is a side elevational view, partly in cross section, of the electronic-component mounting system;

Fig. 5 is a side elevational view, partly in cross section, of a printed-wiring board support

device of the electronic-component mounting system;

Fig. 6 is a side elevational view, partly in cross section, of a portion of a component tray of a tray-type component-supply device in the electronic-component mounting system;

Fig. 7 is a plan view of the electronic component accommodated in the tray;

Fig. 8 is a side elevational view, partly in cross section, of a component mounting unit of the component mounting device of Fig. 3;

Fig. 9 is a side elevational view, in cross section, of a component holding device of the component mounting unit of Fig. 8;

Fig. 10 is a ~~lock~~ block diagram schematically illustrating a control device of the electronic-component mounting system;

Fig. 11 is a flow chart representing an electronic- component mounting routine that is stored in a RAM (random access memory) of a computer in the control device of Fig. 10;

Fig. 12 is a flow chart representing a coplanarity detecting routine that is stored in the RAM of the computer;

Fig. 13 is a flow chart representing another electronic-component mounting routine that may be stored in the RAM of the computer; and

Fig. 14 is a view of an image of an electronic component taken by a coplanarity detecting camera of the electronic-component mounting system.

Please replace paragraph **[0058]** with the following rewritten paragraph:

[0058] Thus, the component mounting device 18 receives electronic components 82 one after another from the component tray 76 in the tray ~~boxy~~ box 78 at the component-supply position above which the required vertical space is provided. Each component tray 76 accommodates the electronic components 82 in component accommodating recesses 80 (Fig. 6) which are arranged in a matrix. Each electronic component 82 accommodated in the corresponding recess 80 is substantially positioned, so that the electronic component 82 can be

held at an almost central portion thereof by the component mounting device 18, and can be taken out of the recess 80, while the electronic component almost maintains predetermined attitude and position relative to the component mounting device 18.

Please replace paragraph **[0062]** with the following rewritten paragraph:

[0062] The component holding device 100 (Fig. 3) of the component mounting device 18 is movable in the mutually perpendicular X-axis and Y-axis directions, so that the component holding device 100 can take a linear movement having at least one of X-axis and Y-axis components, to move each electronic component 82 to a desired position on or above the component-mounting surface 28 of the printed-wiring board 12. To move the component holding device 100 in the X-axis direction, the component mounting device 18 includes two ballscrews 104 disposed on the machine base 10, on the opposite sides of the PWB conveyor 14, so as to extend in the X-axis direction, as ~~sown~~ shown in Fig. 1, and an X-axis slide 106 having two ballnuts 108 (only one of which is shown in Fig. 4) which engage the respective ballscrews 104. The device 18 further includes two X-axis drive motors 110 for rotating the ballscrews 104, for moving the X-axis slide 106 in the X-axis direction. As shown in Fig. 1, the X-axis slide 106 extends in the Y-axis direction across the PWB conveyor 14, and has a length corresponding to the distance between the component supply device 20 of feeder type and the component supply device 22 of tray type. On the machine base 10, there are disposed two guide rails 112 (Fig. 4) located under the respective ballscrews 104. The X-axis slide 106 has two guide blocks 114 which slidably engage the guide rails 112, for guiding the X-axis slide 106 in the X-axis direction. It will be understood that the ballscrews 104, ballnuts 108 and X-axis drive motors 110 cooperate with each other to constitute an X-axis drive device 116.

Please replace paragraph **[0063]** with the following rewritten paragraph:

[0063] On the X-axis slide 106, there is disposed a ballscrew 120 so as to extend in the Y-axis direction, as shown in Fig. 4. The X-axis slide 106 carries a Y-axis slide 122 having a

ballnut 124 which engages the ballscrew 120. The ballscrew 120 is rotated by a Y-axis drive motor 126 (Fig. 1) through gears 128, 130, so that the Y-axis slide 122 is moved in the Y-axis direction while being guided by a pair of guide rails 132 (Fig. 4). It will be understood that the ballscrew 120, ballnut 124 and Y-axis drive motor ~~124~~ 126 constitute a Y-axis drive device 134, and that the Y-axis drive device 134 cooperates with the X-axis slide 106, X-axis drive device 116 and Y-axis slide 122, to constitute an XY moving device 136 for moving the component holding device 100 to a desired position in the XY plane as a plane parallel to the component-mounting surface 28 of the printed-wiring board 12.

Please replace paragraph **[0070]** with the following rewritten paragraph:

[0070] A light emitting plate 206 is fixedly mounted on the outer circumferential surface of the lower end portion of the sleeve 190 which is located outside the chuck 182, while the suction ~~nozzle~~ pipe 192 is partially fitted in the inner circumferential surface of the lower end portion of the sleeve 190, such that the suction ~~nozzle~~ pipe 192 extends downwards through the light emitting plate 206. When the position of the electronic component 82 held by the suction nozzle 184 is detected, the light emitting plate 206 receives an ultraviolet radiation, and generates a visible light toward the component 82.

Please replace paragraphs **[0079]-[0082]** with the following rewritten paragraphs:

[0079] A UV irradiating device, not shown, is disposed near the reflecting mirror 252, for irradiating the light emitting plate 206 of the suction nozzle 184 with an ultraviolet radiation. The light emitting plate ~~106~~ 206 absorbs the ultraviolet radiation, and emits a visible light for illuminating the top surface 94 of the electronic component 82 held by the suction nozzle 184. The component camera 250 takes a silhouette image of the electronic component 82 in the axial direction of the suction nozzle 184, with the light emitting plate 206 used as a light background. In the present embodiment, the light emitting plate 206 and the UV irradiating device cooperate to constitute an illuminating device for the image-taking device 248.

[0080] As shown in Fig. 1, a coplanarity detecting camera 270 is fixedly supported by a support member, not shown, at a position corresponding to one of the two ballscrews 104 that is provided, on the machine base 10, between the tray-type component supply device 22 and the board support device 26. The coplanarity detecting camera 270 provides a first image taking device. In the present embodiment, the coplanarity detecting camera 270 is provided by a CCD camera including a matrix of CCDs that defines an image taking surface 272 (Fig. 14). Thus, the coplanarity detecting camera 270 functions as a surface- image taking device capable of taking, at ~~one~~once, a two-dimensional image of the electronic component ~~28~~82.

[0081] As shown in Figs. 1 and 4, the coplanarity detecting camera 270 faces, toward the electronic component 82 held by the suction nozzle ~~18~~184, at a position away from the tray-type component supply device 22 in the X-axis direction perpendicular to the Y-axis direction in which the component supply device 22 and the ~~PWV~~ PWB conveyor 14 are arranged. An optical axis of the camera 270 is parallel to the X-axis direction, but is inclined by a predetermined angle (e.g., 6 degrees) relative to the bottom surface 96 of the main body 90 of the component 82 such that in a direction toward the component 82, the optical axis goes down. The coplanarity detecting camera 270 is aligned, in the Y-axis direction, with one of the image taking devices 248 that corresponds to the tray-type component supply device 22.

[0082] Thus, in a state in which the EC 82 is positioned in the Y-axis direction at a position corresponding the ballscrew 104 between the tray-type component supply device 22 and the ~~PWV~~ PWB conveyor 14, the coplanarity detecting camera 270 can take an image of the EC 82, irrespective of which position the electronic component 82 may take in the X-axis direction. Thus, like the image taking device 248, the coplanarity detecting camera 270 is provided at the position where the camera 270 can take an image of the component 82 on a path of movement thereof caused by the movement of the Y-axis slide 122 relative to the X-axis slide 106. In the present embodiment, the image taking device 248 and the coplanarity detecting

camera 270 are provided at the respective positions where the image taking device 248 and the coplanarity detecting camera 270 can take respective images of the component 82 positioned right above the reflection mirror 252 of the image taking device 248, provided at the position corresponding to the ballscrew 104 provided between the tray- type component supply device 22 and the ~~PWV~~ PWB conveyor 14. As will be described later, the electronic component 82 is moved via the shortest way from the component-supply position of the tray-type component supply device 22 to a component-mounting place on the printed-wiring board 12. During this movement, the component 82 is stopped so that an image of the component 82 is taken by the coplanarity detecting camera 270. Thus, respective images of different electronic components 82 are taken at different positions by the camera 270. However, the focal point of the camera 270 is adjusted according to an X-axis-direction position of each electronic component 82 at a time when an image of the component 82 is taken by the camera 270.

Please replace paragraph **[0087]** with the following rewritten paragraph:

[0087] When electronic components 82 are mounted on a printed-wiring board 12, first, the board 12 is carried in by the ~~PWV~~ PWB conveyor 14, and is stopped at the component mounting position by a stopper, not shown. Then, the clamping members 40 and the support members 42 are lifted up, so that the printed- wiring board 12 is clamped and supported.

Please replace paragraph **[0091]** with the following rewritten paragraph:

[0091] Each electronic component 82 supplied from the tray-type component supply device 22 is mounted on the printed-wiring board 12, as follows: First, the component holding device 100 is moved by the moving device 136 to the tray-type component supply device 22, and holds the component 82 by suction. Subsequently, on a way to the board 12, the holding device 100 is stopped at the position right above the reflecting mirror 252 of the image taking device 248 provided between the tray-type supply device 22 and the ~~PWV~~ PWB conveyor 14, so that first an image of the component 82 is taken by the coplanarity taking camera 270.

Please replace paragraph **[0092]** with the following rewritten paragraph:

[0092] In the present embodiment, the main body 90 of the electronic component 82 has a square shape in its plane view, and has four identical sides from each of which a predetermined number of leads 92 extend. Therefore, each time an image of one side of the component 82 is taken, the component 82 is rotated by 90 degrees about its axis line. That is, the four sides of the component 82 are sequentially positioned at an image-taking angular position where each of the four sides extends substantially parallel to the Y-axis direction and substantially perpendicularly to the optical axis of the coplanarity detecting camera 270, at a position between the axis line of the component 82 and the camera 270. After respective images of the four sides of the component 82 are taken, the control device 300 processes four sets of image data representing the four images taken by the camera 270, and detects a coplanarity of the leads 92 of the component 82.

Please replace paragraph **[0095]** with the following rewritten paragraph:

[0095] First, at Step S0 of the electronic-component mounting routine of Fig. 11, the control device 300 judges whether flag F3 is set ON, indicating that an electronic component 82 is held by the suction nozzle 184. Since the F3 flag is initially reset to OFF according to the main routine, a negative judgment is made at Step S0. Accordingly, the control goes to Step S1 to operate the suction nozzle 184 to hold an electronic component 82. More specifically described, the component holding device 100 is moved by the moving device 136, so that the suction nozzle 184 is moved to a position right above one of a number of electronic components 82 stored in the component tray 76 that is to be picked up. Then, the nozzle 184 is lowered by the Z-axis drive device 144, so that the suction pipe 192 contacts the electronic component 82 and the suction supplied to the nozzle 184 is applied to the top surface ~~194~~ 94 of the component 82. Thus, the nozzle 184 holds the component 82. Thereafter, the nozzle 184 is lifted up to take the component 82 out of the tray 76, and is moved by the moving device 136 toward the printed-

wiring board 12. During this movement, the nozzle 184 is stopped so that an image of the component 82 is taken.

Please replace paragraph **[0112]** with the following rewritten paragraph:

[0112] If the amount of deviation of each of the respective lengths of all the leads 92 of the electronic component 82 is judged as being smaller than an appropriate one of the reference values Δ L1, Δ L2, then the control device 300 additionally judges whether a coplanarity among the four groups of leads 92 corresponding to the four sides of the component 82 is acceptable. Though the main body 90 of the component 82 may be more or less inclined relative to the component-mounting surface 28 when the component 82 is mounted on the board 12, the leads 92 can be suitably connected to the electric circuits provided on the board 12, if the leads 92 are substantially uniformly placed on the board 12. In the present embodiment, this judgment is made by first determining a virtual plane that is least deviated from the four regression lines determined for the four sides of the component 82, then determining an amount by, and a direction in, which each of the four regression lines is deviated from the virtual plane, and finally comparing the thus determined deviation amount and direction with an appropriate one of two reference values that are predetermined for two possible deviation directions and are, in the present embodiment, equal to each other. If the amount of deviation of each of the regression lines is smaller than an appropriate one of the two reference values, the control device 300 judges that the coplanarity of all the leads 92 of the component 82 is acceptable. On the other hand, if the amount of deviation of at least one of the regression lines is <u>not</u> smaller than an appropriate one of the two reference values, the control device 300 judges that the coplanarity of all the leads 92 is not acceptable.

Please replace paragraph **[0116]** with the following rewritten paragraph:

[0116] In addition, in the case where an electronic component 82 is mounted, on the printed-wiring board 12, at the <u>same</u> angular position as that at which the component 82 is held

by the suction nozzle 184, if the angular position of the component 82 is changed, during the coplanarity detecting operation, to an angular position different from that at which the component 82 is to be mounted, a positive judgment is made at Step S6, so that the control goes to Step S7 to change the angular position of the component 82 to that at which the component 82 is to be mounted. Step S7 is followed by Step S8.

Please replace paragraph **[0119]** with the following rewritten paragraph:

[0119] Concurrently with the above-described image-data processing operation, the control device 300 moves the component ~~mounting head 60~~holding device 100 to a position right above a component-mounting place on the printed-wiring board 12. Then, the control goes to Step S10 to lower the suction nozzle 184 to mount the electronic component 82 at the component-mounting place on the component-mounting surface 28 of the board 12. In addition, the control device 300 resets flags F1, F2, F3 and thereby ~~finalizes~~ quits the routine of Fig. 11. During the movement of the component 82 toward the component-mounting place, respective distances of movement of the component holding device 100 in the X-axis and Y-axis directions are so changed as to correct the positional errors ΔX, ΔY of the component 82 and the positional errors $\Delta X'$, $\Delta Y'$ of the component-mounting place of the board 12, and additionally the component 82 is so rotated as to correct the angular-positional error $\Delta\theta$ thereof. Thus, the component 82 is mounted, on the board 12, at the correct component-mounting place and the correct angular position.

Please replace paragraph **[0123]** with the following rewritten paragraph:

[0123] On the other hand, if the coplanarity of the leads 92 of the electronic component 82 is judged as unacceptable, a negative judgment is made at Step S5, and the control goes to Step S11 to discard the unacceptable component 82. In the present embodiment, the suction nozzle 184 releases the unacceptable component 82 onto a discharging conveyor, not shown, provided on the machine base 10. The discharging conveyor is located at a predetermined

discarding or discharging position within a range in which the component holding device ~~10~~ 100 is allowed to move around, and the holding device 100 is moved to a position right above the discharging conveyor to place and release the component 82 onto the conveyor.

Please replace paragraph **[0135]** with the following rewritten paragraph:

[0135] It is possible to detect a coplanarity of the leads of each of the electronic components supplied from the feeder-type electronic-component supply device 20. In this case, a coplanarity detecting camera 270 is provided at a position corresponding to the ballscrew 104 that is provided, on the machine base 10, between the supply device 20 and the ~~PWV~~ PWB conveyor 14, and a flat light emitter 280 is provided on the X-axis slide 106 such that the light emitter 280 faces the camera 270. Thus, a coplanarity of the leads of each electronic component supplied from the supply device 20 can be detected in a short time. For example, in the case where the supply device 20 supplies electronic components in the form of a carrier tape, such that the components are accommodated in respective accommodating recesses formed in the carrier tape and accordingly are substantially prevented from being moved out of position, each of the components is prevented from being largely rotated about its axis line, so that the component mounting device 18 can hold the substantially central portion of the each component with its correct angular position. Thus, a coplanarity of the component can be detected based on an image thereof taken without carrying out the previously-described preliminary inspection. However, the preliminary inspection may be carried out, ~~ias~~ as needed.

Please replace paragraph **[0136]** with the following rewritten paragraph:

[0136] It is possible to use only a single combination of a coplanarity detecting camera and a background forming device to detect a coplanarity of leads of each of electronic components supplied from a plurality of electronic-component supplying devices. For example, the coplanarity detecting camera 270 and the flat light emitter 280 facing the camera 270, both provided between the tray-type electronic-component supply device 22 and the ~~PWV~~ PWB

conveyor 14, may be used commonly for the two supply devices 20, 22. After the component holding device 100 takes an electronic component from the feeder-type supply device 20, and before the holding device 100 mounts the component on the printed-wiring board 12, the holding device 100 is moved in the Y-axis direction to the position aligned with the coplanarity detecting camera 270, so that an image of the component held by the device 100 is taken by the camera 270 and a coplanarity of the component is detected. The commonly used coplanarity detecting camera and flat light emitter may be provided at a position equally distant from the two supply devices 20, 22.